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Module 04: Hazardous Waste

Urban EcoLab


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April 2021

## Student Pages - Mercury Case Study: Mystery of the Dancing Cat

Center for Urban Resilience

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### Repository Citation

Center for Urban Resilience, "Student Pages - Mercury Case Study: Mystery of the Dancing Cat" (2021).  
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Name: \_\_\_\_\_ Date: \_\_\_\_\_ Class/Period: \_\_\_\_\_

**MERCURY CASE STUDY: The Mystery of the Dancing Cat**

Please respond to the following True-False questions before you begin reading:

"Tremors" are uncontrolled shaking.	True	False
Methylmercury is a byproduct of Acetaldehyde production.	True	False
Methylmercury acts on the digestive system of humans and cats.	True	False

After reading the narrative, would you like to change any of your responses? If yes, what changes would you make? Why?

*I would like to change...*

## CASE STUDY

**This mystery is based on true events that happened in Japan in the 1950s. Follow the story and complete the exercises to discover, as real scientists did, what happened at Minamata.**

**Location: A small fishing village in Minamata, Japan**

**Time: 7:00 AM**

Imagine one day you were walking down the street when you see a cat start to dance. When you get closer you see that the cat is not actually dancing, it is convulsing and appears to be in pain. The violent tremors of the cat's limbs and body prevent you from getting close enough to help and in a little while the cat dies right there in the street.



[http://commons.wikimedia.org/wiki/File:Gato\\_callejero\\_en\\_Madrid\\_02.jpg](http://commons.wikimedia.org/wiki/File:Gato_callejero_en_Madrid_02.jpg)

Although disturbing you don't think much about the incident.

Later you are talking to a friend when he begins to tell you an eerily familiar story.

"I was walking past the market today, you know where the cats usually feed on the scrap fish bones and parts, and this cat starts shaking, it was practically jumping in the air, and then all of a sudden it falls down dead!"

You then tell your friend of your similar experience. You both decide it is more than a coincidence, and you start off to look around the town. Sure enough, you find another dead cat.

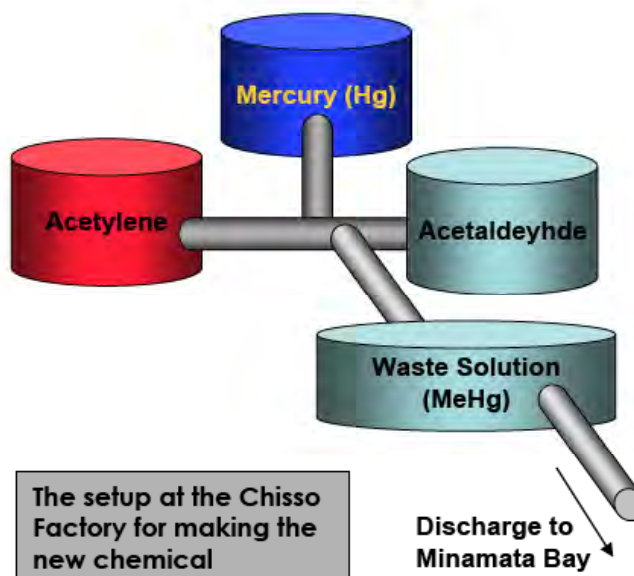
All the cats look normal on the outside, but the violent shaking shows that the problem has to be based in their nervous system. But what could be affecting their nervous system?

One of your friends at a nearby university is a medical student so you decide to take one of the cats to him for an autopsy. After you drop off the cat you have to go to work at the nearby Chisso factory.

It is only your first week at the plant and you are being trained to make a chemical called Acetaldehyde. Basically you have to mix Acetylene with a metal called Mercury to have a reaction which creates Acetaldehyde. Acetaldehyde is important because it is required to make the various products your company produces. You have a look at the set up of the area of the plant where you work.

**Location: The Chisso Corporation Time: 9:00AM**

You see that the byproduct of Acetaldehyde production is a Methyl group bonding with the Mercury making Methylmercury (**MeHg**). You notice that the waste solution leads to a big pipe that leaves the factory. **If they are discharging the mercury into the Bay it must be safe right?**



**Location: Your Family's House Time: 7:00PM**

You return home to your family's house after a long work day. Your father has had a successful fishing trip and dinner includes fish, rice, and some vegetables. You sit at the table trying to explain to your parents the new reaction your company is using for its products but they do not really seem interested. Your father would rather have you help him fish.

When you are done explaining your job, your father begins to open his mouth to reply, but no words come out. Suddenly the chopsticks fall from his hand, rattling as they hit the table and fall to the floor. Your father, surprised, regains his composure, apologizes, and begins to speak normally. The rest of dinner is uneventful but your father's tremor remains in the back of your mind.

The next morning as you are leaving for work, you notice your father struggling with one of his broken nets. His hands are again visibly shaking each time he tries to stitch the rope. He tries to tell you it is nothing important, but as he speaks his whole body suddenly sways and he falls to his knees.

You rush him to a doctor who has him in bed around the clock. **Over the next month the tremors worsen, and your father dies.** Although you are very upset you are now determined to figure out what is going on in your town.

You have your same friend at the medical school do an autopsy on your father.

### Autopsy Follow-Up

You are surprised and upset to learn that Methylmercury is responsible for your father's poisoning and the cats' poisoning. This is undoubtedly from the Methylmercury that is being put into the bay by the company that pays you to work.

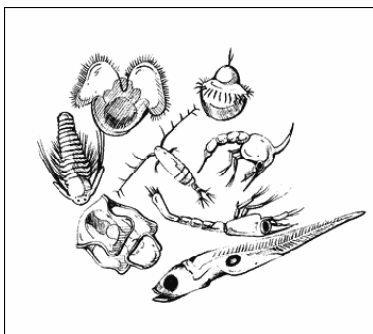
You confront another worker who is in charge of safety at the Chisso plant.

"Why would you let that Methylmercury discharge into the bay?" you ask angrily. "The amount of mercury isn't so bad," he says, "It's not like people are drinking the sea water." He is right, so why is the mercury so bad in humans and cats?

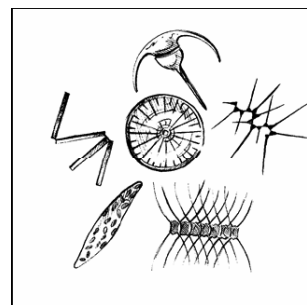
Your friend at the medical school suggests that **this kind of poisoning is typically from a contaminated food source**. "You ought to take a look at the food web in Minamata Bay." You don't know much about the food web, so you set out to do some sampling in the nearby waters. You find many different organisms.

### Organisms of Minamata Bay

These are the organisms you sampled from Minamata Bay. Read the descriptions and complete the sentences before you draw the food web on the next page.



These are **zooplankton**. Zoo- means animal and "Plankton" is Greek for "little floater." Most plankton are no bigger than the head of a pin and they float because they cannot swim against the ocean current. They are so numerous there can be hundreds in just a few spoonfuls of ocean water. Many zooplankton eat phytoplankton which makes them \_\_\_\_\_ **consumers**.



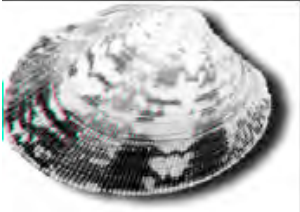
These are **phytoplankton**. Phyto- means plant so these are plant-like plankton, they are like the grass of the sea. Phytoplankton make their own food with PHOTOSYNTHESIS, so they are called \_\_\_\_\_. Phytoplankton do not eat other organisms. On the food web they are \_\_\_\_\_ **producers**.



The **shore crab** is a scavenger that eats a variety of organisms, so they are called \_\_\_\_\_. Most of its diet is phytoplankton, algae (another plant-like producer) and some zooplankton. However, they can also eat dead or dying fish when they are easier to catch. On the food web they are \_\_\_\_\_ **or** \_\_\_\_\_ **consumers**

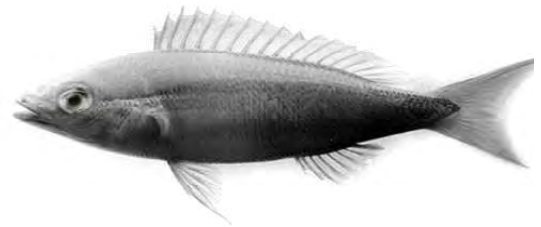


This is the **gray mullet**. Mullet generally grow to about one foot in length and although they are large, they eat mostly phytoplankton and some zooplankton. On the food web they are \_\_\_\_\_ **consumers**.



The **short-necked clam** is a shellfish that live on the ocean floor among rocks and stays in a small area throughout its lifetime. Although it is sedentary, they stick a special tool called a “siphon” out of their shell and vacuum up plankton. This behavior makes them a \_\_\_\_\_ **consumer** on the food web.

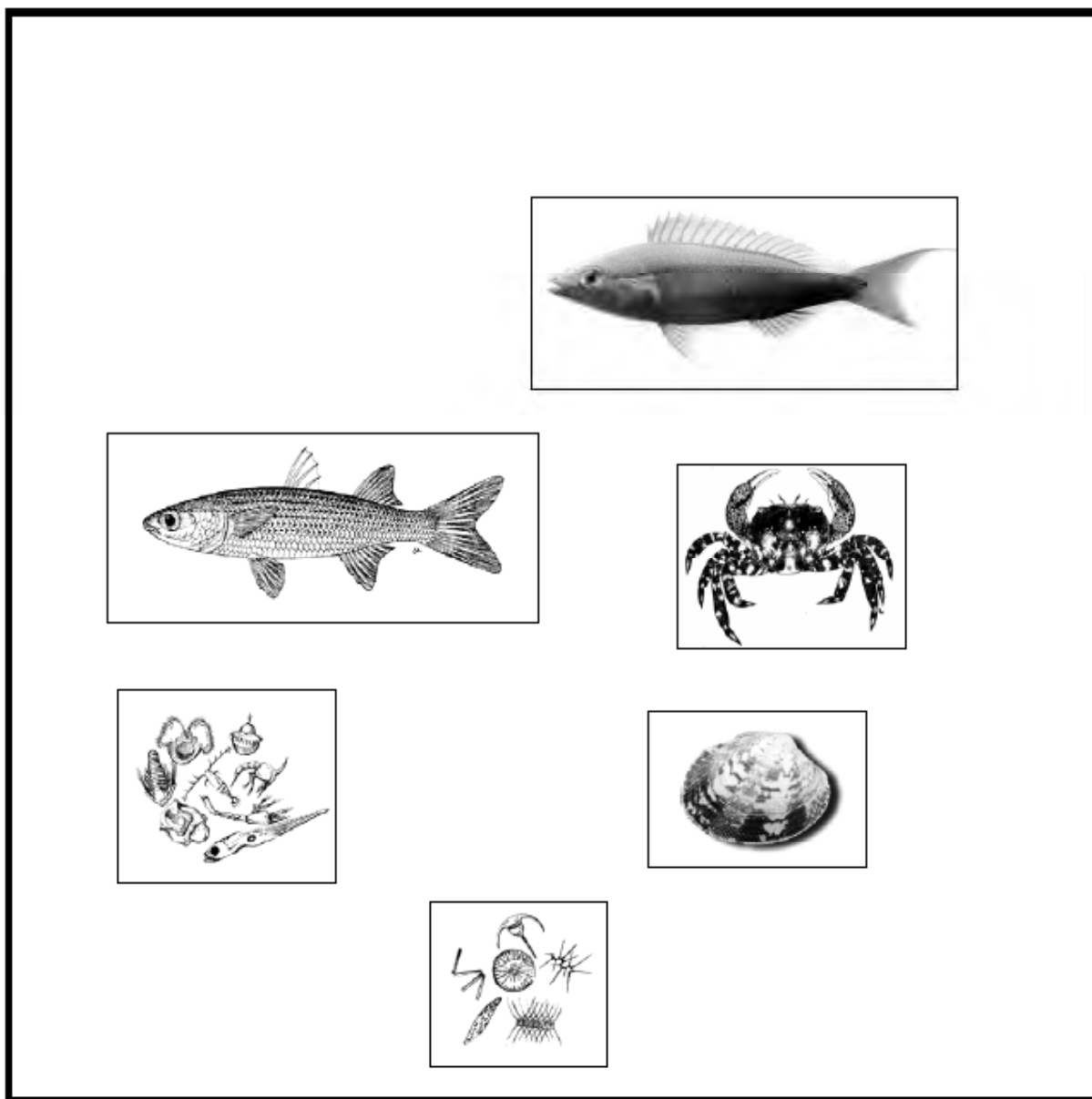
The **China Fish** is a predator that eats other fish, clams, and large zooplankton. This behavior makes them a \_\_\_\_\_ **consumer** on the food web.



### **Connecting the Food Web of Minamata Bay**

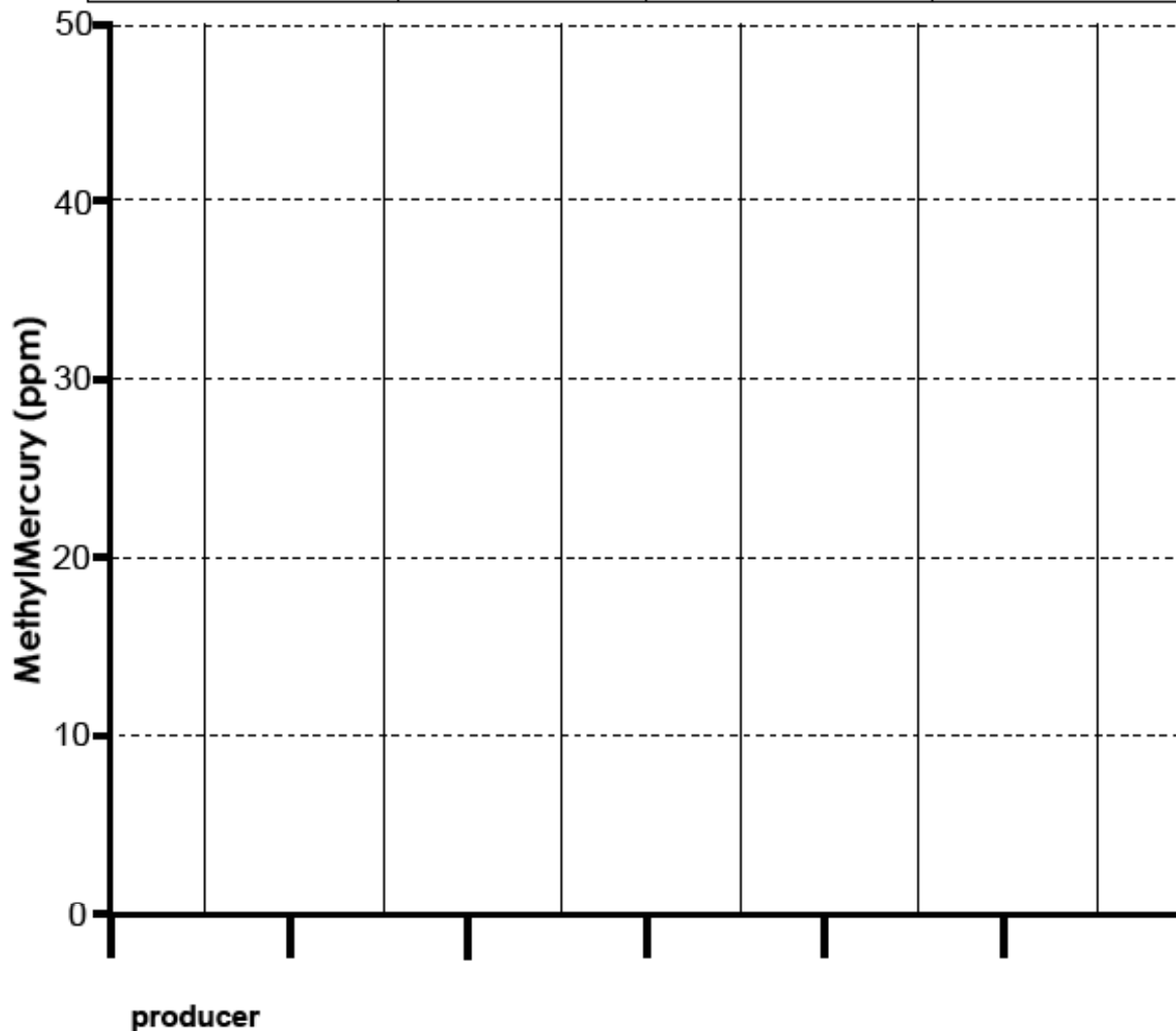
So now you have all these organisms in jars. You are hypothesizing that some or all of these critters have mercury in them.

You decide to send all your specimens back to the lab for mercury analysis. Before you can understand the results you have to reconstruct the food web. Connect the pictures below to illustrate the food web.



**Next, examine and analyze the results from the mercury concentration in the organisms of the food web.**

Organism	Mercury (ppm)	Organism	Mercury (ppm)
Short-Necked Clam	20.0	China Fish	24.1
Phytoplankton	3.2	Crab	35.7
Gray Mullet	10.6	Zooplankton	6.8



**Step 1:** From left to right order the organisms from the table according to their position in the food web. Start with the PRODUCER on the left and end with the Secondary CONSUMER on the right. Graph the amount of mercury found in their body with a dot ( )

**Step 2:** Draw a slope line that approximates the trend of the dots. (This does not mean connect the dots).

**Step 3:** In one sentence describe the relationship between Methylmercury concentration and movement up the food web.

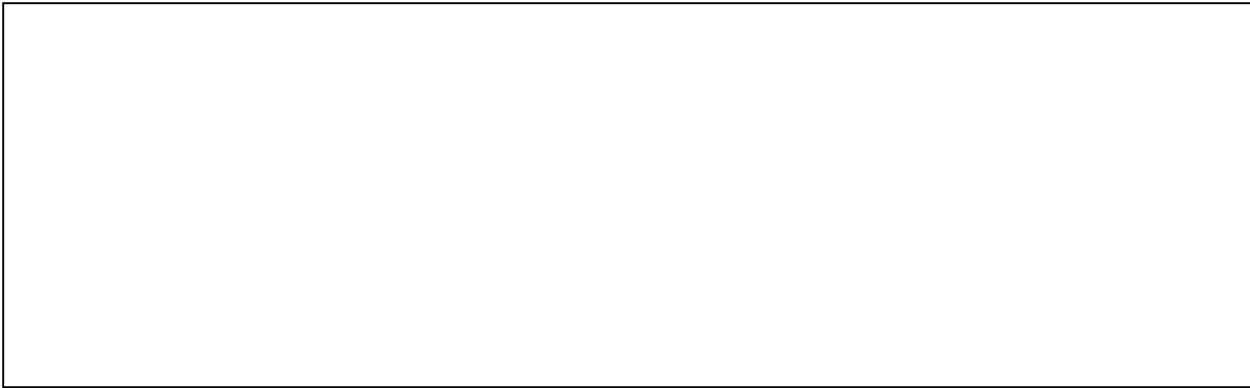
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## Notes on the Biomagnification Demonstration



### Mystery Solved

The fish in Minamata Bay were so contaminated because the low levels of methylmercury accumulated up the food web, and the fish, tertiary consumers, receive the most concentrated mercury toxin. **Humans who ate the fish showed significant problems in their ability to move, and function because methylmercury harms the central nervous system.** Common symptoms are shaking, loss of balance, and blurred vision.

Cats have very similar nervous systems compared to humans. Imagine what a cat might look like if it is shaking, losing its balance, and having blurred vision. It might look like it was dancing, right? **That is what was happening to our poor cat, it had methylmercury poisoning.**

### **Activity 5.3: Framing Injustice**

#### **How do we understand the injustice of Minamata?**

Take notes on the economic and environmental situation of the Chisso Company and the Minamata Fishing Village

## Minamata Disease

In Minamata there were more and more cases of newborns with severe birth defects. As they grew older the telltale deformities of the limbs, and tremors showed the symptoms of the Mercury poisoning. But how was this possible? The young people had not eaten any fish. How had they contracted the disease?

A developing baby in the womb of a mother exposed to contaminants is very vulnerable to the same toxins **through the umbilical cord**. You may have heard that smoking cigarettes and drinking alcohol during pregnancy can harm the developing fetus. The same is true for pregnant mothers exposed to mercury from eating contaminated fish. This transfer of toxins from mother to baby is a major danger of environmental toxins for any organism. The transfer is called CONGENITAL transfer, so in this case the mercury poisoning is called **Congenital Minamata Disease**.

## Conclusion

The mercury poisoning of the Minamata Fishing Village is one of the first and most devastating cases of industrial pollution on record. We learned that by traveling from the water into the food web, hazardous metals such as mercury can come to harm humans who eat from the top of the food web.

It is estimated that from the early 1930s until the 1950s about 600 tons of methylmercury contaminated water were dumped into Minamata Bay by the Chisso Company. Since the first discovery of the cause of the diseases, similar to the mystery you've uncovered, there have been 3,000 people found to be affected by the mercury poisoning. Some economic compensation has been won for the victims, but court battles were still happening as recently as 8 years ago. After many years the Chisso company has reduced the amount of the mercury and changed some of its hazardous operations.

1. In Wikipedia (<http://en.wikipedia.org/>) look up the term

**“Minamata Disaster”**:

What is the most interesting point you learned from this web page?

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2. Using the Internet, find a definition of **Environmental Justice** and write it here:

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3. Visit the webpage (<http://www.ejnet.org/ej/principles.html> ) and read the “**Principles of Environmental Justice.**” Pick your favorite principle and describe why you like it.

Principle # \_\_\_\_\_

I liked this principle because \_\_\_\_\_

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